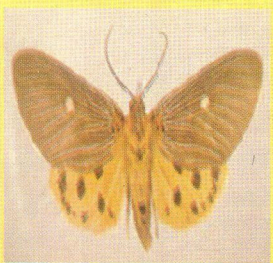
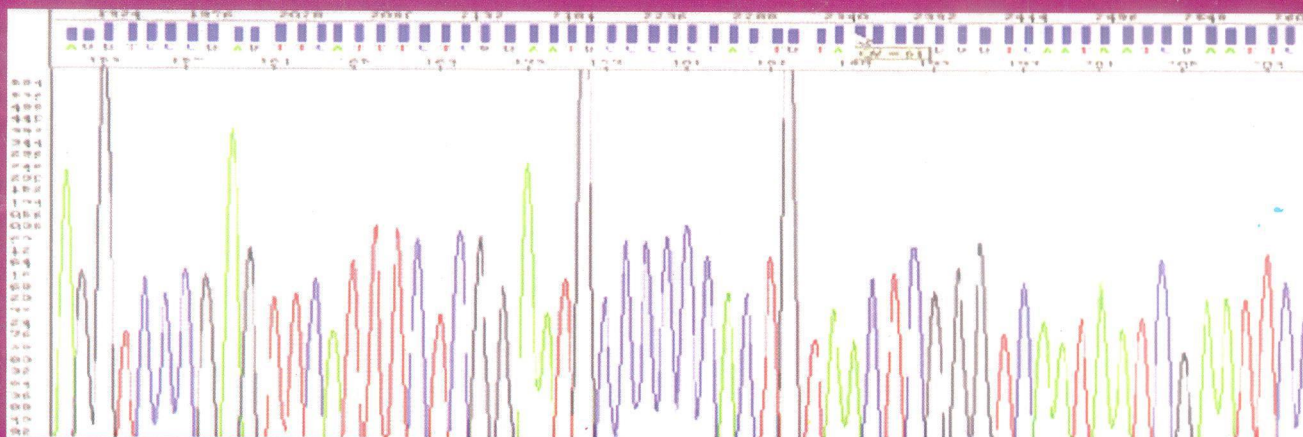
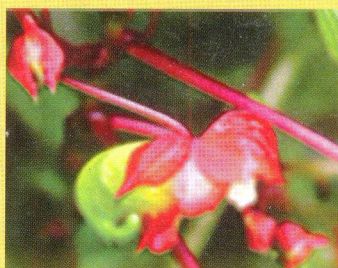
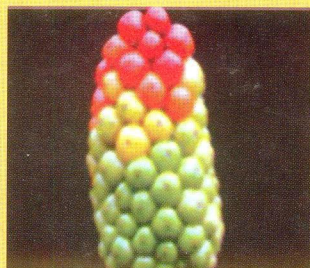




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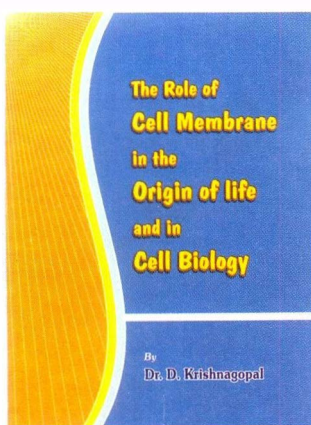
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DNA Barcoding: Its application in plant and animal studies

BOOK OF THE MONTH

The Role of Cell Membrane in the Origin of Life and in Cell Biology



Title	The Role of Cell Membrane in the Origin of Life and in Cell Biology
Author	Dr. D. Krishnagopal
Publisher	Dr. D. Krishnagopal
Pages	48

The author, Dr. Krishnagopal makes a chief hypothesis that 'life on the Earth has originated in the primordial cell membranes'. The author described the three fundamental properties of life, namely: consciousness (awareness), metabolism and reproduction. Consciousness is the hallmark of all life and this is the result of 'relentless firing of membrane potentials'. He argues that consciousness is the most fundamental characteristic of life and the seat of consciousness is the cell membrane. Hence, it appears that the membrane originated first on the Earth.

The Section I of the book describes a possible theory of formation of cell from primordial membranes. The primordial membranes had formed in nature from a 'mass of hydrocarbon molecules' which formed in the Earth's crust as the Earth started cooling down. When hydrocarbon molecules were surrounded by water they coalesced to form layers, which later acquired 'polar heads' at their ends due to chemical reactions induced by static electricity present in the ambient atmosphere.

The author postulates the occurrence of a 'unique, sudden and short-lived massive electrical event', about 3.5 to 4 billion years ago which induced membrane potentials across these primordial membranes. The development of 'will' to survive and to reproduce is left to the reader as open-ended questions.

As these primordial layers acquired membrane potentials they developed a mechanism by which a continuous supply of energy is supplied to 'fire' the membrane potentials. This created metabolism. The membrane potentials were generated across the membrane by chemical reactions akin to cellular respiration (the author calls it 'inorganic respiration'), which was the first evidence of catabolism. To

have a controlled environment for the metabolism to continue, the membranes had 'closed on themselves' to form cells (which he calls 'phantom cells').

Soon, the changing environmental conditions and depleting resources of energy made the cells to invent anabolic metabolism to store food, which could be converted into chemical energy on demand.

He hypothesizes that continuous erosion of hydrocarbon chains by electrical potentials had resulted in the formation of organic molecules like sugars, aminosugars, amino acids and fatty acids. The need for 'repetitive tasks' had resulted in 'chemical etching' of the nucleic acids possibly from the aminosugars.

An interesting proposition is made that archaea may be 'aliens among us' basing on the unique composition and structure of its membrane.

All these hypotheses are speculative, as in the case of any hypothesis concerning origin of life, but would appear credible if the reader begins to think from a different perspective. The commonly accepted hypothesis (the RNA World theory) of abiogenesis supposes that RNA formed from the primordial soup which later acquired reproductive capability. But this lacks the driving force and purpose for the self assembly of the macromolecules which is essential to the formation of life.

In support of his hypothesis, the author makes a few other hypotheses asserting the central role played by the cell membrane in cellular events.

He presumes that the today's cell membrane has microdomains to 'modulate' the electrical potentials passing through them to perform several tasks occurring in a cell. These microdomain modulated membrane potentials (MMMPs) have a role in the mechanism of memory, cell division, gene expression and metabolism.

He tries to explain the occurrence of an interesting phenomenon called 'bouquet formation' during meiosis with the help of MMMPs. He proposes that the telomeres conduct the membrane potentials, and for this reason the chromosomes assemble near the nuclear membrane during homologous pairing. He argues that, in cloning, the cell membrane programmed the dormant nucleus into a potential embryonic form, thereby forming an embryo from the adult cell.

Though these views are mere conjectures, as the author himself admits, he has a talking point in the realms of scientific research. Of course much research remains to be done to prove or disprove these theories.

Finally he suggests that the membrane-bound organelle such as mitochondria and chloroplasts are formed from invaginations of specialized cell membrane microdomains. This theory is also highly conjectural, as he admits.

To summarize, the new theory of origin of life is fresh and promising, and the theoretical scientists may take a note of this in their research.

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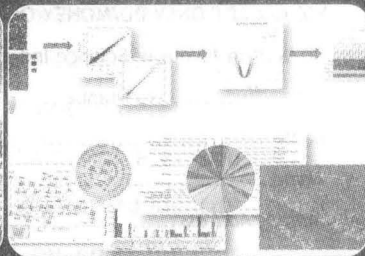
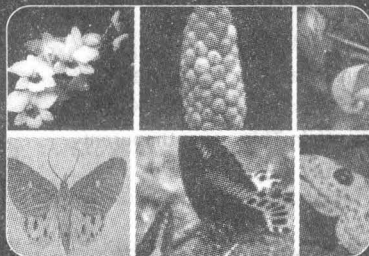
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Editorial



DNA barcoding is a taxonomic method that uses a short genetic marker in an organism's DNA to identify it as belonging to a particular species. It differs from molecular phylogeny in that the main goal is not to determine classification but to identify an unknown sample in terms of a known classification. Although barcodes are sometimes used in an effort to identify unknown species or assess whether species should be combined or separated, the utility of DNA barcoding for these purposes is subject to debate.

DNA barcoding first came to the attention of the scientific community in 2003 when Paul Hebert's research group at the University of Guelph published a paper titled "Biological identifications through DNA barcodes". In it, they proposed a new system of species identification and discovery using a short section of DNA from a standardized region of the genome. That DNA sequence can be used to identify different species, in the same way a supermarket scanner uses the familiar black stripes of the UPC barcode to identify your purchases.

Applications of DNA barcoding include, for example, identifying plant leaves even when flowers or fruit are not available, identifying insect larvae (which typically have fewer diagnostic characters than adults), identifying the diet of an animal based on stomach contents or faeces, and identifying products in commerce (for example, herbal supplements or wood).

A special article on 'DNA barcoding: Its application in plant and animal studies' appears in this issue of Science India. Another noteworthy article in this issue is on 'Integrating the intricate genetic networks by microarrays'.

Team Science India



DNA barcoding: Its application in plant and animal studies

Dr. P. Manoj

DNA barcoding provides an efficient means by which many undescribed species that exist on earth can be discovered. It has been widely used to identify animal species since its invention few years ago. This discovery is important because understanding the biodiversity is crucial to long-term human existence on the planet. However, its use for plants was delayed because of the complex nature of plant genetics. Previously, scientists had difficulties in reaching a consensus on which DNA region, or indeed how many regions, to use. For the first time, the botanists involved in evaluating plant barcoding regions have pooled their data to agree on a standardized approach.

This involved comparing the performance of the seven leading candidate DNA barcoding regions on a common set of samples. Plants are essential to our survival and that of most other animals on earth. It is easy to overlook this fact because they have become discretely embedded into our everyday lives. Plants provide us with food, medicines, and raw

materials used by our industries. In spite of their importance, very few of us could name more than a tiny fraction of the plants that surround us. The primary application of the methodology will be the identification of the many species in the world's biodiversity hotspots where a shortage of specialists hinders

conservation efforts. Other applications include identifying illegal trade in endangered species, identifying invasive organisms, poisonous species and fragmentary material in forensic investigations. The technique will work on minute amounts of tissue and can be used on fragments of plant material, small seedlings, and in some cases

digested or processed samples. The methodology will also be used immediately to build the DNA barcode database for all the species of the world, many of which are of economic and conservation importance.

The goal of DNA barcoding is to find a simple, cheap, and rapid DNA assay that can be converted to a readily accessible

The goal of DNA barcoding is to find a simple, cheap, and rapid DNA assay that can be converted to a readily accessible technical skill that bypasses the need to rely on highly trained taxonomic specialists for identifications of the world's biota.



technical skill that bypasses the need to rely on highly trained taxonomic specialists for identifications of the world's biota. This is driven by a desire to open taxonomic identifications to all user groups and by the short supply of taxonomists that do not even exist in many groups.

How barcoding can be done ?

DNA barcoding is a taxonomic method that uses a short genetic marker in an organism's DNA to identify it as belonging to a particular species. It differs from molecular phylogeny in that the main goal is not to determine classification but to identify an unknown sample in terms of a known classification. Although barcodes are sometimes used in an effort to identify unknown species or assess whether species should be combined or separated, such usage, if possible at all, pushes the limits of what barcodes are capable of. Applications include, for example, identifying plant leaves even when flowers or fruit are not available, identifying the diet of an animal based on stomach contents or feces, and identifying products in commerce (for example, herbal supplements or wood).

A desirable locus for DNA barcoding should be standardized (so that large databases of sequences for that locus can be developed), present in most of the taxa of interest and sequencable without species-specific PCR primers, short enough to be easily sequenced with current technology, and provide a large variation between species but a relatively small amount of variation within a species.

Although several loci have been suggested, for animals and many other eukaryotes, the mitochondrial CO1 gene for land plants are the concatenation of the *rbcl* and *matK* chloroplast genes.

What is mitochondrial DNA ?

DNA barcoding is based on a relatively simple concept. Most eukaryote cells contain mitochondria, and mitochondrial DNA (mtDNA) has a relatively fast mutation rate, which results in significant variation in mtDNA sequences between species and, in principle, a comparatively small variance within species. However, because all mtDNA genes are maternally inherited (direct evidence for recombination in mtDNA is available in some bivalves such as *Mytilus*) but it is suspected that it may be more widespread, any occurrences of hybridization, male-killing microorganisms, cytoplasmic incompatibility-inducing symbionts, horizontal gene transfer (such as *via* cellular symbionts), or other "reticulate" evolutionary phenomena in a lineage can lead to misleading results (it is possible for two different species to share mtDNA, or for one species to have more than one mtDNA sequence exhibited among different individuals). A 648-bp region of the mitochondrial Cytochrome c Oxidase subunit I (COI) gene was proposed as a potential 'barcode'. As of 2009, databases of CO1 sequences included at least 620,000 specimens from over 58,000 species of animals, larger than databases available for any other gene. A 'barcode' gene that can be used to distinguish between the majority of plant species on



Earth has been identified. This gene, which can be used to identify plants using a small sample, could lead to new ways of easily cataloguing different types of plants in species-rich areas like rainforests. It could also lead to accurate methods for identifying plant ingredients in powdered substances, such as in traditional medicines, and could help to monitor and prevent the illegal transportation of endangered plant species.

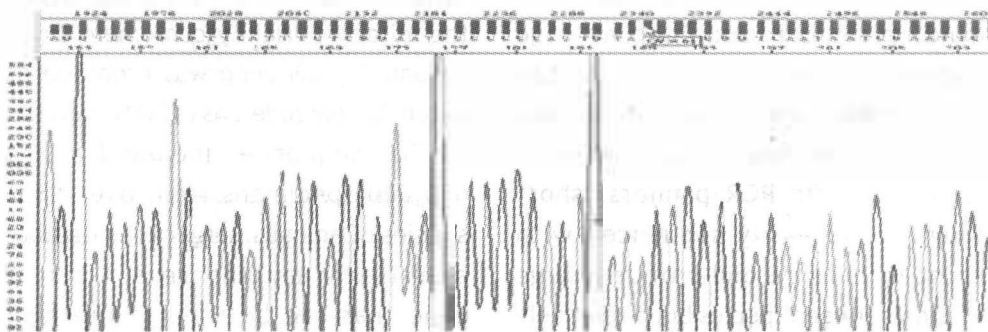
Mitochondrial genome lack introns, its limited exposure to recombination and its haploid mode of inheritance makes it a better target. The mitochondrial genome includes just 13 protein-coding genes that might serve as the core of a DNA based identification system. The mitochondrial genes like Cytochrome c Oxidase subunit I (COI), Cyt b, NADH subunit 4(ND4), and NADH subunit 5(ND5) are widely used for the purpose.

"Barcode" the world's plants

An international team of 52 scientists working in 10 countries, including botanists from the University of Johannesburg (UJ), has concluded a four

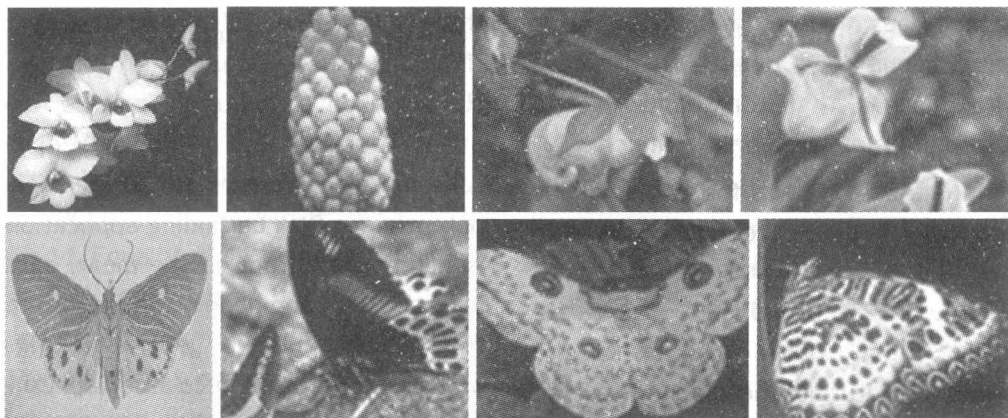
year effort to agree on a standard 'plant DNA barcode' to provide the foundation for the widespread use of DNA technologies to identify plants. Dr. Michele van der Bank is the lead investigator of the project at UJ. The University is also playing a leading role in Africa as the continent's representative for the new TreeBOL initiative (DNA barcoding of all the trees of the world). Michelle van der Bank and Olivier Maurin are heading the regional working group for Africa. Their aim is to facilitate the transfer of precise and reliable information between the continent's tree collections and the rest of the world, and also to build capacity in Africa.

During the past two years UJ has collected approximately 80% of the tree species of southern Africa, which forms part of the TreeBOL Africa project and has also set up several collaborated projects with researchers in Africa. One of many barcoding projects currently at UJ is the barcoding of protected timber and traded trees in Africa to assist custom officials at the ports/borders. Dr. van der Bank's team has completed the barcoding project for all trees and shrubs of the



DNA sequences will help in the database preparation





The DNA barcode will enable researchers assess the diversity of species in the world's biodiversity hotspots

Kruger National Park. They are using the standardized protocol for plants to barcode all these species and are adding it onto the BOLD (Barcode of Life Database).

Barcodes based on portions of DNA - the taxonomical equivalent to UPC barcodes on products - have already emerged as a viable solution for uniquely identifying species in many animal groups. However, because DNA varies less between plant species, determining which portions of plant DNA to use as a unique identifier has been a thorny issue. Theoretically, any DNA

barcoding standard would have to accommodate over 400,000 species of plants, and would be a key step toward establishing a central barcode database for taxonomy, agriculture and conservation. The 2008 International Union for Conservation of Nature Red List categorized 8,457 out of an evaluated 12,055 species of plants as endangered,

but notes that only four per cent of total plant species have been evaluated. Those evaluations tend to focus on areas losing biodiversity and plant families that are endangered. Estimates of the total number of endangered plants vary from 13 per cent to 37 per cent.

DNA barcoding was developed for rapid identification but it also provides information about the habits and history of species. DNA barcoding can play an important role in studying the arrival of invasive species. We need to understand the genetic history of invasion in order to combat the pests

DNA barcoding was developed for rapid identification but it also provides information about the habits and history of species.

that threaten trees and crops. DNA barcoding can pinpoint the geographic source of an invading species and measure the distances over which pest species can travel. Using a technique of DNA barcoding, which involves the identification of species from a short DNA sequence, Weiblen and an international team of researchers studied populations

of numerous moth and butterfly species across Papua New Guinea. DNA barcodes showed that migratory patterns and caterpillar diets are very dynamic.

In one case, it was found that a tiny moth that is distributed from Taiwan to Australia, has recently crossed thousands of miles of Pacific Ocean. Sea turtle species can provide insight into the genetic structure of the widely-dispersed and ancient group of animals. This is the first study to document DNA barcodes of all species of sea turtles from around the world. These barcodes can be used to document biological diversity in a standardized fashion and for the conservation of these charismatic and ecologically important marine animals. DNA barcodes are relatively short segments of mitochondrial DNA. A region of the COI or Cox1 gene (Cytochrome c Oxidase subunit 1) has been agreed-upon by researchers as appropriate for barcoding, given that it is both highly variable and very specific. This portion of the genome mutates quickly enough to distinguish many closely related species but also slowly enough so that individuals within a species may have similar barcodes. Barcoding has been used to check the accuracy of Caviar and Red snapper labeling and to identify the presence of endangered whales in Asian markets, as well as other applications. By identifying these animals to species and providing a standardized registry for documenting genetic diversity within this group, DNA barcoding promises to advance conservation and research. Highly migratory sea turtles face a myriad of

threats worldwide from overharvest, fisheries interactions, habitat loss, climate change, pollution, disease, and other factors, and hence effective conservation measures are needed. The potential for DNA barcoding applications is significant. Trade in the meat, eggs, leather, shell, and bone often means that the species identity or geographic origin of a product is difficult to ascertain using conventional means. Barcoding items collected by wildlife management could provide critical information and tools to those tracking international trade in wildlife products. In addition, animals trapped as fisheries bycatch or stranded onshore may be damaged beyond recognition, but identifiable through DNA barcoding. To assist in these efforts, barcode sequences from various studies have been supplied to the Barcode of Life Database and GenBank so that the data are freely available.

Creating a large-scale inventory of plant biodiversity is essential for the development of conservation strategies. Within the framework of the Convention on Biological Diversity, the use of DNA barcoding was proposed for the identification of plant and animal species. This method consists of using tissue to sequence short DNA fragments which contain a substantial amount of information. These fragments are then compared to a reference collection to identify their origin. In August 2009, after several years of debate, an international consensus headed by the Working Group of the Consortium for the Barcode of Life (CBOL) was reached, according to which



two DNA markers (two gene regions dubbed *rbcl* and *matK*) would suffice to characterize 250,000 plant species.

Accurate plant identification on a large scale is nevertheless vital if we are to protect the most biodiverse regions of the world. Equally, plant identification based on DNA could help in the search for new sources of pharmaceutical drugs, check ingredients in food and industrial products or provide a new source of forensic information for criminal investigations. One of the critical issues surrounding the DNA barcoding debate is that using a section of DNA may not adequately distinguish among closely related species or complex groups. Moreover, in plants, there is still much debate over which gene sequence region should be used and its reliability. In animals, the 5' segment of mitochondrial Cytochrome Oxidase subunit I (COI) is relatively established as a barcoding marker, but in many groups, COI fails to distinguish species. The COI region fails completely for plants because it evolves at a slower rate in plants and has a much more variable sequence. The search for alternative barcoding regions in plants is especially problematic. Although several gene sequences have been proposed for plants, none of them serves as a universal barcode marker. Regions that have been proposed for plants include a section of the nuclear ribosomal DNA: the Internal non-Transcribed Spacer region (ITS); and various plastid regions to include the *trnH-psbA* intergenic spacer and the plastid genes *rpoC1*, *rpoB*, and *matK*.

There was too much intraspecific variation in the nuclear ITS region and the plastid markers did not have enough variation and thus failed to group together some well-supported species. DNA barcoding needs to be accepted with great caution because in many cases it is limiting to the identification or in some cases even the definition of a species to a small sequence of DNA. Thus the search for a DNA barcoding marker that reliably identifies the majority of life forms will be a continuously elusive goal. As a uniform method for species identification, DNA barcoding will have broad scientific applications. It will be of great utility in conservation biology, including biodiversity surveys. It could also be applied where traditional methods are unrevealing, for instance identification of eggs and immature forms and analysis of stomach contents or excreta to determine food webs. In addition to enabling species identification, DNA barcoding will aid phylogenetic analysis and help reveal the evolutionary history of life on earth.

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The Unique Ecosystem Called Myristica Swamps

M.M. Safeer

Swamps are one of the unique ecosystems in the world. Their uniqueness is based on the non-availability or availability of natural resources that include water, oxygen, etc. In India, wetlands and swamps are of much importance because they cater to the need of millions of people, who directly or indirectly depend upon it, for livelihood. According to the Ramsar Convention, swamps can be static or flowing, fresh, brackish or salty, including marine areas.

In India, estuarine swamps are the major type of swamps found along the vast coastlines and estuaries. The mangroves of Sundarbans are the largest estuarine

Most of the freshwater swamps of India are found in association with some river and its watershed basin. The swamps may remain inundated for most or a certain part of the year. Due to these conditions, the plants and animals that survive here are adapted to withstand such extreme conditions.

swamps in India and the world. It is well known for its characteristic estuarine ecosystem, and its population of Royal Bengal tigers. Most of the fresh-water swamps of India are found in association with some river and its watershed basin. The swamps may remain inundated for most or a certain part of the year. Due to these conditions, the plants and animals that survive here are adapted to withstand such extreme conditions.

Freshwater swamps are also a major type of ecosystem classified under the Indian forests by Champion and Seth (1968). Freshwater swamps usually occur at the foot hills of Himalayas (Rao, 1994) and along other river basins of our great rivers such as the Ganges and Brahmaputra. There is also a network of swamps in the valleys of Western Ghats formed by perennial rivers.

The Western Ghats are blessed with unmatched wealth of natural resources. The nature's endless bounty is seen in this area in its maximum, in every biotic and abiotic form, making it one of the hottest of hot spots in the world. About 1700 higher plant species are endemic to Western Ghats alone. Its richness and abundance of life is due to the unique geographic and climatic factors, high



rainfall, relatively high humidity, along with enough tropical sunlight. On an average the southern regions of the Ghats receive about 2000-7000 mm of rainfall per annum. These rains give life to a number of perennial rivers, with a large number of fauna and flora are dependant on them. These rivers on reaching the plains meanders on their course towards the sea, accumulates at some place forming permanent freshwater ecosystems, swamps and marshes.

In the Western Ghats region, swamps occur at valleys of hills and associated regions. They are characterised by its uniqueness in biota and ecosystem (Champion and Seth, 1968). *Myristica* swamp is one such freshwater swamp ecosystem, found below altitudes of 500 m from mean sea level (MSL). Now it is mostly found in the southern parts of Western Ghats (Krishnamoorthi, 1960), particularly in Kollam district of South Kerala, Uttara Kannada district of Karnataka, and Goa (Chandran and Mesta, 2001). In Kerala, *Myristica* swamps are found under Anchal, Kulathupuzha and Shenduruny forest ranges of Kollam district. In Karnataka, it is found in areas under forest range of Siddapur, Kyadgi and Amenhalli. Small patches of *Myristica* swamp is also reported from the Satari taluk of Goa (Santhakumaran *et al.*, 1995). These swamps, if undisturbed remains inundated through out the year, except for slight change in the water levels. Ecologically it is an ancient type of ecosystem that has an entirely different type of microclimatic condition.

***Myristica* swamp biota**

Myristica swamps, as the name suggests is inhabited mainly by wild varieties of *Myristica* (nutmeg) trees. The family Myristicaceae is one of the primitive types of Angiosperms (flowering plants) with 18 genera and over 300 species widely distributed all along the tropical forest regions. They are plants that can survive in swamps under permanent water logged conditions. Some of these trees are endangered and listed under the IUCN red list. *Myristica* sp., *Pandanus*, *Holigrana* sp., *Anacardium* sp., *Terminalia* sp. etc. are some of the trees found here. Trees like *Myristica fatua* var. *magnifica*, *Myristica malabarica*, *Gymnacranthera canarica*, *Semecarpus kathalekanensis*, *Knema attenuata* etc. are the other major tree species found in the swamps. Moreover there are also a number of other ground plants, climbers and ferns that dwell on the swamp floor. The occurrence of different trees and plants varies with the locality. The various varieties of Pteridophytes found in and around the swamp are *Osmunda* sp., *Selaginella* sp., *Pteris* sp. etc. Most of the tree and herb species found here are highly endemic and some are included in the red list.

A wide range of faunal population including amphibians, reptiles and annelids dwell in the swamps making it a unique ecosystem distinct from the surrounding forest ecosystem. The occurrence of fishes, molluscs, amphibians, annelids like leeches, snakes and arboreal mammals are common sight in the *Myristica* swamps.

The trees in the swamps normally grow straight with slender boles and dark green leaves. The canopy cover is almost complete and hardly any light passes through it. Generally, the trees belonging to *Myristicaceae* family shows capability of producing aerial roots under inundated condition. This peculiar property is also exhibited by the *Myristica* trees in the swamps of Western Ghats. The negatively geotropic roots, knee roots and stilt roots are the main characteristic features of the swamp, distinguishing it from the surrounding forests. The stilt roots help the tree to support itself in the swampy soil. Knee roots rise from the base of the tree above the water level of swamp in order to exchange atmospheric gasses. The swamp floor is completely covered by a network of these roots, making it difficult to traverse through.



Stilt roots produced by the *Myristica* trees



Stilt roots produced by the *Myristica* trees



Knee roots produced by *Semicarpus kathalekanensis*

Swamp soil

The soil typology of *Myristica* swamps vary from place to place depending on the geology and surrounding forests. The soil is usually very weak in structure and easily gives away under foot. The organic matter content of the soil is very high as it is replenished with leaves and other plant debris during each dry season, forming a permanent bed. Once the rainwater accumulates over the swamp floor during annual showers, the decaying matter gets submerged and starts rotting. This process requires a lot of oxygen. But due to less drainage, water stagnation occurs, creating an anaerobic condition. Soon the anaerobic bacteria start decomposing the organic



matter by releasing methane and Carbon dioxide, making the soil toxic to roots.

Watershed values of *Myristica* swamps

Myristica swamps are a unique ecosystem that has lot of unseen values. Most of the swamps in the Western Ghats are found along the valleys or catchment area of rivers. These swamps are classified under the permanently flooded wetlands (Gopal *et al.*, 1995), which remains inundated throughout the year. The main source of water to the swamp is rain, which collect through streams that drain into the swamps. The swamps percolate the water received through rains and the inflowing river at a steady rate and slowly release it throughout the year, giving rise to many forest rivulets. These rivulets may otherwise dry up during summer months. The swamps also act as a source that recharges the local aquifers (Cunningham and Saigo, 1990). Thus the involvement of *Myristica* swamps in the hydrological cycle of the area provides its due value.

The swamp itself exhibits a primitive type of ecosystem; hence it can be helpful for the evolutionary biologists to study the various facts regarding the evolution of flowering plants. The unique microclimatic conditions in the swamp and the high degree of endemism, exhibited in both faunal and floral diversity also opens up wide area of research. The variation in the swamp biota, in accordance to the locality itself shows the species diversity in *Myristica* swamps. The swamp also harbours a number of economically important medicinal plants like *Myristica*

malabarica, *Piper longum*, many varieties of Zingibers, *Calamus* sp. etc.

The present position of *Myristica* swamps

The major attraction of *Myristica* swamps for the researchers and scientists is its primitive and unique type of ecosystem. Much about these swamps is still unknown and remains as a mystery. Recent studies by Kerala Forest Research Institute (KFRI), Peechi and Indian Institute of Science (IISc), Bangalore have unravelled many unknown facts about the *Myristica* swamps. Studies about the faunal and floral diversity, their occurrence and adaptation to the swamp environment have made a real breakthrough in the knowledge about *Myristica* swamps.

A shocking aspect that came to light during the study at KFRI was that the *Myristica* swamps are under serious threat of extinction. For years *Myristica* swamps have remained pristine and untouched. But today they are facing serious problems of degradation. Fragmentation and intrusion by foreign species of plants are the two main problems affecting the ecosystem of swamps. Major portions of the swamps have been converted to agricultural lands for areca and other plantation crop cultivation as early as 1950. Recent survey by KFRI shows that the *Myristica* swamps of Kerala are found in about 50 different patches, most of them under constant threat of degradation. Foreign plant species like *Acacia* sp., *Lantana* sp. and many other deciduous trees that grow on the banks

of the swamps are beginning to grow in the swamp area due to receding water levels.

The changing habitats of surrounding forest lands, erratic rainfall and human intrusion like felling of trees for timber, firewood and cash crop plantation are the major problem of *Myristica* swamps of Karnataka. Diversion of the courses of streams from forests for agricultural purposes have also caused the drying up of swamp leading to its degradation in many parts of Uttara Kannada district.

The swamps in Kulathupuzha forests in Kerala also have a similar story to tell. A local resident of the area says: "These swamps had water throughout the year, hence were found to be the best place to cultivate cash crops and rice. During the kingship rule, large parts of swamps were handed over to the farmers to be cleared for rice cultivation when there was a serious shortage of food". These parts are no longer used for rice production. Instead it is now been turned into rubber plantations. Parts of the forests are also planted with *Acacia* and *Eucalyptus* trees by the Forest Department itself. All these are sure to sound the death knell of the unique ecosystem which has survived for centuries.

Suggestions for swamp conservations

The occurrences of long dry spells, sudden rains and changing average annual temperatures have changed the microclimatic balance of the swamps that have evolved over a period of time. The loss of a major portion of *Myristica* swamps

was due to ignorance and lack of knowledge. The only way by which this precious treasure of nature can be protected is by proper surveying, recording and protection of the swamps and related forest lands. Buffer zones of forests around the swamps should be maintained to protect the swamp ecosystem preventing trespassing and conversion to agricultural lands. The swamps and the adjoining river catchment area are to be protected from building roads and clearing for agricultural purposes. The public and locals should be made aware of the values of *Myristica* swamps. Special protection measures by the forest department should be enforced to check the status of the swamps and prevent it from degradation.

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Integrating the intricate genetic networks by microarrays

Dr. Swati Subodh

The past decade has seen the completion of genome projects and launching of many high throughput platforms which enable a genome-wide view of the organism. Microarray is one such platform which enables the study of DNA, RNA and protein of the organism. This information integrates the three strata of genomics to generate functionally relevant information which ultimately works towards better clinical and therapeutic applications.

Within ten years since the human genome was first sequenced, our understanding, aided by rapidly-evolving technologies, has advanced to reveal the complex architecture of genetic traits, including genetic basis of common diseases, intricacies of gene regulation and the role of non-coding portions of our

genome, to name but a few. This decade has seen dramatic changes as a

consequence of the development of techniques and tools that allow the collection of biological information at an unprecedented level of detail and in extremely large quantities. The nature of information, now available, opens directions of research that were once in the realm of science fiction. Pharmacogenomics, diagnostics and drug target identification are just a few of the many areas that have the potential to use this information to change

dramatically the scientific landscape in life sciences. Microarray is one of the ways in which a burgeoning amount of data can be viewed at a global scale and sieved to understandable, coherent information for the researcher. It comes under the purview

The past decade has seen the completion of genome projects and launching of many high throughput platforms which enable a genome-wide view of the organism. Microarray is one such platform which enables the study of DNA, RNA and protein of the organism. This information integrates the three strata of genomics to generate functionally relevant information which ultimately works towards better clinical and therapeutic applications.

of a closed system in biological research tools as the information made available from these experiments is well annotated and its functionality established. It is a good starting point for understanding the broad biology of the system under study and hence identification of specific areas for identification of specific pathways, drug targets etc.

In very simple terms, microarray is a system for studying the genome (DNA, RNA or protein) at a global level taking a bird's eye view. The probes used to characterize or identify the target (from the investigational sample) are arranged in microscopic arrays, thus a small chip of 1cm x 1cm will contain millions of probes which represent the information from the entire genome. Microarray gives a snapshot of all or a large set of genes and understands the networks of bio-molecular interaction. It allows the interrogation of thousands of genes at the same time in a single experimental set up and thereby opens innumerable possibilities of understanding the underlying biology of the system.

The process of using the information encoded in a gene to produce the coded protein involves reading the DNA sequence

of the gene. The transcription process converts the information coded by the DNA into a RNA sequence. This 'expression' of the gene can be determined by various internal and external factors. The objective of researchers is to determine and quantify gene expression levels under particular circumstances. Classical method of doing so for a few genes was by hybridization methods such as Southern Hybridization. These methods, although robust, can investigate only a few genes

at a time in a hypothesis driven study. However one may ask as to the reason of measuring the expression of all known genes. An important reason is the necessity to understand the biological networks. Small changes in expression levels can determine major changes at the organism level and induce illnesses such as cancer.

Microarray gives a snapshot of all or a large set of genes and understands the networks of bio-molecular interaction. It allows the interrogation of thousands of genes at the same time in a single experimental set up and thereby opens innumerable possibilities of understanding the underlying biology of the system.

In its most general form, a DNA array is usually a substrate on which one deposits single stranded DNAs (ssDNA) with various sequences. If the purpose is to understand the way a particular set of genes function, the surface will contain a number of regions dedicated to those individual genes. When used in gene expression studies, the DNA target used to hybridize the array is obtained by



reverse transcriptase reaction from the mRNA extracted from a tissue sample. This DNA is fluorescently labeled with a dye and a subsequent illumination with an appropriate source of light will provide an image of the array of features. The intensity of each spot or the average difference between matches and mismatches can be related to the amount of mRNA present in the tissue and in turn, with the amount of protein produced by the gene corresponding to the given feature. Constitutive genes, spiked DNA, unrelated DNA and no DNA serve as different controls to measure the correctness of a microarray set up. Same probes at different locations and in varying numbers on the array measure the robustness of the observations. The detection methods may change between different arrays, from two colour DNA arrays to single colour expression array, the chemistry, the labeling procedures etc. will vary to generate the most sensitive and coherent data sets.

Genesis of microarray

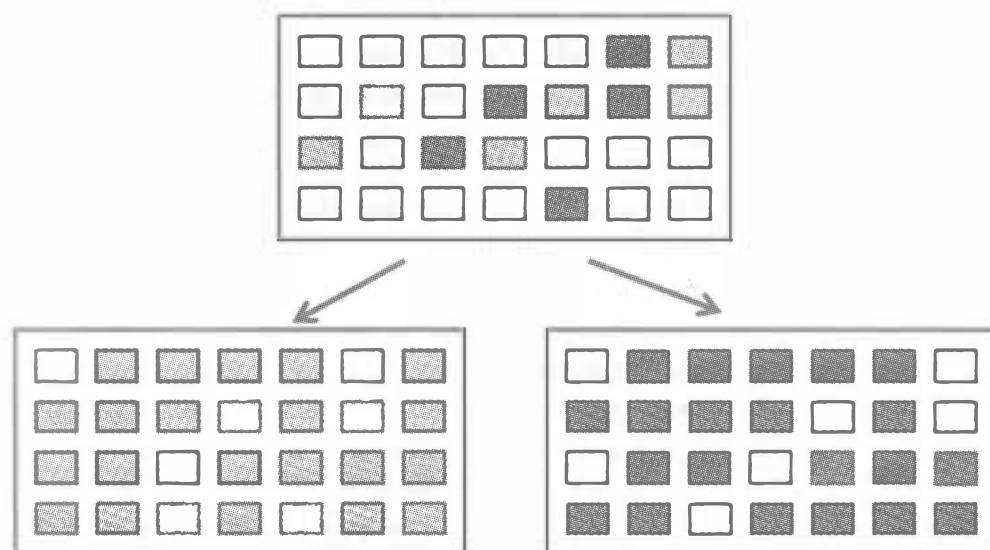
Genome projects targeted at the sequencing of various organisms like drosophila, mouse, cynaeobacterium, *Arabidopsis* etc. started in the 1980s and 1990s. The commencement of the Human Genome Project (HGP) in 1990 has been a turning point in many ways and has been responsible for the genomic revolution that the last two decades have seen. It identified approximately 20,000-25,000 genes of the human genome from both a physical and functional standpoint. The remaining genome comprises of

hypothetical genes, non-coding regions etc. A progression from HGP was the HapMap project. Instead of focussing on obtaining the DNA sequence from a single individual, the HapMap Project encompassed genetic variation among the human populations. Information arising out of these different genomic projects has given rise to many investigational tools; microarray being one of them. From less than 200 publications per year in 1999 pertaining to microarrays to about 800 publications in 2001 (the first draft of HGP was released in 2000) to over 1500 publications in 2003 (final draft of HGP was released in 2003). Today different variants of microarrays are available to study the entire genome and its numerous networks.

Types of microarrays

The choice of arrays is driven by the scientific questions behind the investigation although many strategies, chemistries and protocols are now available for microarray chip fabrication. This article describes the two most commonly used ones.

Spotted arrays/cDNA microarrays: In the spotted arrays, or the 'Home made' arrays, DNA is prepared away from the chip. Robots dip thin pins into the solutions containing the desired DNA material (mostly in a cloned form) and then touch the pins onto the surface of the arrays. Small quantities of DNA are deposited on the array in the form of spots. Spotted arrays can use small sequences, whole genes or even arbitrary PCR products. The



A two colour microarray

DNA can be of longer size which can be spotted onto designated sites on the slide and in as many replicates as the researcher desires. DNA from the control and test samples can be differentially labeled and hybridized onto the same chip and analyzed together. Instead of a whole genome scan, the spotted array can be 'customized' to spot and investigate only those genes which are of interest to the researcher.

Oligonucleotide arrays/ *in situ* synthesis:

In these arrays the probes specific for a particular region of the DNA are photochemically synthesized on the chip. There is no cloning, no spotting and no PCR carried out. Probe selection is performed based on sequence information alone. Here the size of the probe is limited by the chemistry by which the probe is synthesized. The *in situ* synthesis of microarray fabrication is represented by three approaches. The methods are photolithographic (Affymetrix), ink jet

(Agilent), and finally electrochemical synthesis (CombiMatrix, Bothel, WA).

Variants of the oligonucleotide arrays:

1. **Exon arrays:** These arrays offer gene-level and exon-level data as well as the potential to predict alternative spliced transcript forms.
2. **Whole genome expression arrays:** These arrays are targeted at the different transcripts, of known and candidate genes to understand the expression of transcripts across the entire genome.
3. **SNP/CNV arrays:** These arrays identify differences in chromosomal copy number and single nucleotide polymorphisms, thus providing insights into the fields such as cancer biology and other genome-wide association studies (GWAS).
4. **Epigenetic/Regulatory arrays:** These arrays help in gaining insights to



mechanisms of transcriptional and translational regulations.

5. Sequencing arrays: The arrays offer analysis methods that provides greater information about sequences represented on the chip.

6. Array based cytogenetics: Structural variability is a substantial source of genetic variation that has a major influence on phenotypic variation. Microarrays now allow researchers to profile chromosomal aberrations such as amplifications, deletions, rearrangements, point mutations, copy number changes, and copy-neutral loss of heterozygosity (LOH) events.

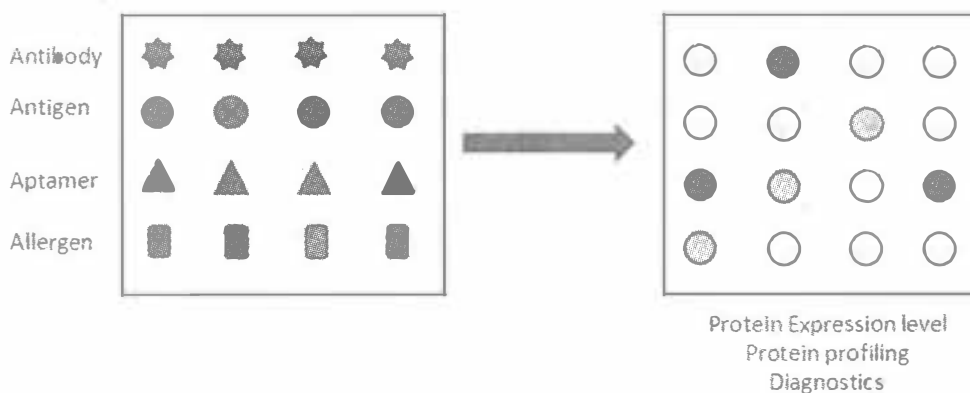
It is difficult to make a judgment as to the superiority of a given technology. At this point of time, the cDNA technology seems to be more flexible, allowing spotting of almost any PCR product whereas the oligonucleotide technology seems more reliable and easier to use.

cDNA can incorporate longer probe sequences as compared to oligonucleotide arrays and is easier to analyze. However in oligonucleotide arrays each spot has an identifiable sequence and generates a more reliable data when compared to cDNA arrays.

Besides the DNA and RNA microarrays, protein microarrays are also now being used widely for studying specific protein types in different organisms. Researchers have long known that the concentration of an mRNA within a cell is poorly correlated with the actual abundance of

that protein. This is due to the fact that the rate of degradation of individual mRNAs and proteins differ, post-transcriptional control of protein translation, a number of post-transcriptional modifications of protein, and protein degradation by proteolysis. By measuring the amount of the specific protein directly, we are measuring a true level of gene function. However, when one takes into consideration the large number of post-translational modifications, human cells may contain a million or more different protein variants, any of which could be altered in disease making the task of analyzing all of them a huge one. Protein microarrays or protein chips may allow for a solution to this problem. A slide or "chip" could be spotted with thousands of known antibodies or peptides like a DNA microarray, a biological sample spread over the chip, and any binding determined. Binding could also be analyzed using standard proteomic techniques such as time-of-flight mass spectrometry (MS) and peptide mass fingerprinting. Protein chips can thus become a fast and high-throughput method of profiling protein changes in disease. These chips are used to analyze protein activities, binding properties and post-translational modifications. With the proper detection method, functional protein microarrays can be used to identify the substrates of enzymes of interest. Consequently, this class of chips is particularly useful in drug and drug-target identification and in building biological networks.



*Protein Microarrays*

Regulators of genetic mechanisms

In an organism the genetic pathways are subject to the action and modification by various regulators. These regulators may act at the transcription and translation levels and affect the overall expression profile for not only for certain genes but for the entire pathway in which genes may be involved. It is thus important to know the basis of these regulations, a common objective of doing so is to identify the potential targets of therapeutic intervention and designing of therapy models.

At the DNA level, epigenetic factors as base methylation or acetylation can determine which DNA fragment is transcribed and which is not. The DNA strand also interacts with proteins which may have structural (eg: histones) or functional (eg: polymerase) relevance. The genome has various patterns of these epigenetic modifications which if altered could greatly affect the downstream genetic mechanisms.

DNA Microarrays allows for the study of such changes of the genome by means

of methylation arrays (containing whole genome methylation profiles) and ChIP on chip arrays (CHromatin Immuno Precipitated DNA). Thus in a single reaction it is possible to view such modifications on a whole genome basis between different study cases in a matter of two to three days.

At the RNA level, the downstream translation may be regulated by factors such as micro RNA (miRNA) and proteins. Recent reports highlight the role of miRNA as critical effectors in the intricate host-pathogen interaction networks. Evidence suggests that both virus and hosts encode miRNAs. This gives the virus an opportunity to fight or modulate the host according to its needs. The mechanism of action of miRNAs is considered to be by two modes-translational repression (mammalian systems) and target degradation (plants). Thus the range of interactions possible through miRNA-mRNA cross-talk at the host-pathogen interface is large. These interactions can be further fine-tuned in the host by changes in gene expression, mutations and polymorphisms. Recent reports suggest



that miRNA profiles can be used not only to classify different classes of cancers, but also as biomarkers for diagnosis and prognosis of disease states.

Translational regulatory proteins have been known and documented by many researchers. Their role in the normal genetic regulations and their aberrant role leading to certain physiological conditions are also known. Host heterologous ribonucleoprotein K (hnRNP K) has been shown recently to be a determining factor in Hepatitis B virus replication efficiency and a possible target for pharmacologic intervention. Analysis and identification of such proteins is facilitated when a direct comparison of RNA binding proteins can be done between case and controls at a whole genome level.

New microarray chips are now available for understanding the differential regulations at the transcriptional and translational levels. One such is microRNA microarray which is a high throughput method for studying microRNA expression in cultured cells or tissues. Compared to traditional cDNA microarray expression profiling, RNA samples used for microRNA microarray hybridization are required to be enriched for small RNAs which are of 20-30-nt in size. An understanding of the microRNA population in a sample when studied together with the whole genome expression profile can help identify genes which are regulated by this mechanism. Additionally, this information can be juxtaposed to gene sequences to identify potential seed sequences in genes which

may be regulated by a variant of a microRNA. This aspect is being explored in the area of microRNA based alternative therapeutics.

At the protein level, the modifications in terms of phosphorylations, acetylations, aminations etc. can modulate the activity or the structure. A protein microarray, sometimes referred to as a protein binding microarray, provides a multiplex approach to identify protein-protein interactions and to identify the substrates of such proteins.

The role of bioinformatics

Microarrays and bioinformatics form the core of functional genomics. Essentially, bioinformatics is the science of refining biological information into biological knowledge using computers. Most researchers face the challenge to analyze, interpret and understand all data that are being produced. A high throughput technology as microarrays presents an incredibly large amount of data which needs to be properly analyzed and interpreted to make any biologically relevant information. Several programmes, softwares and scripts are now available, freely and commercially, to achieve this task. Statistical packages allow for selecting the most significant genes associated with the biological condition under study and also in the identification of outliers. Co-regulated genes may be identified by hierarchical clustering and their association with different pathways can be analyzed by various pathway modeling tools. This, along with Gene Set Enrichment Analysis



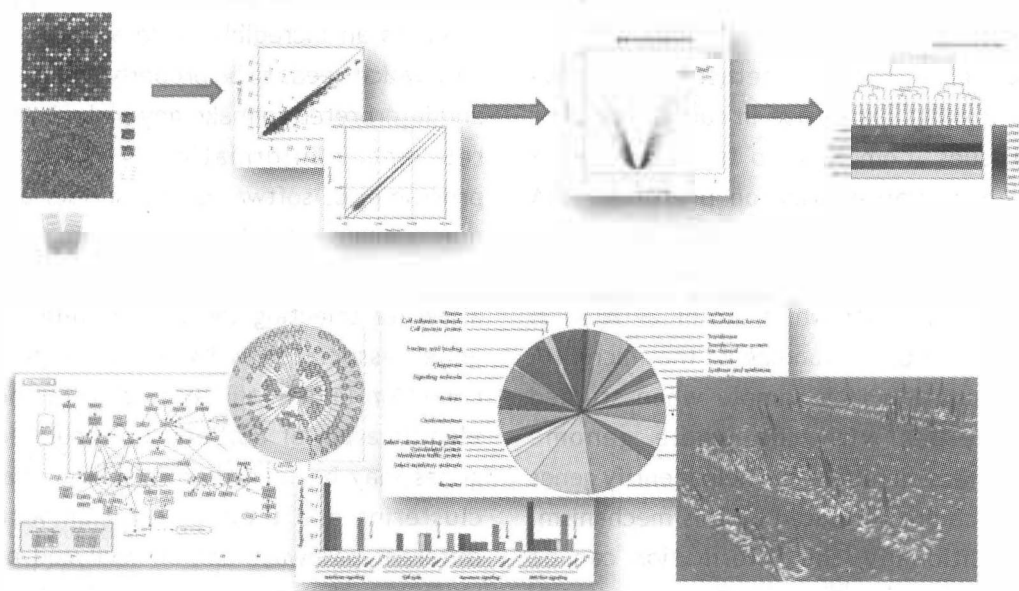
(GSEA) gives comprehensive information into the differentially regulated genes and their role. A researcher now has genes and pathways which are most significantly associated with the disease or condition and which thus forms the starting point by being the target for therapeutic intervention. Essentially, microarray and bioinformatic processing of the data enables a whole genome view in a global unbiased perspective to a specific target for future interventions. This feature of microarray is unparallel since it enables simultaneous study of the whole genome of many organisms to reach a conclusion.

Applications

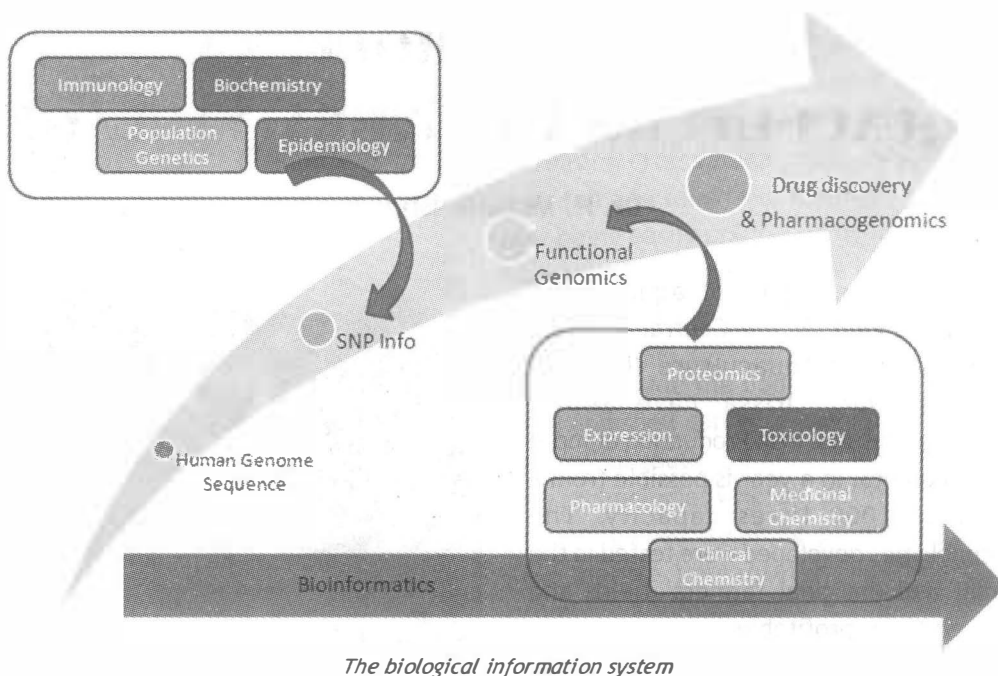
One can study the effects of drugs or stressors by monitoring the gene expression levels. Gene expression can be used to understand the phenomena related to aging or fetal development.

Screening tests for various conditions can be designed if those conditions are characterized by specific gene expression patterns. Drug development, diagnosis, comparative genomics, functional genomics and many other fields may benefit enormously from a tool that allows accurate and relatively inexpensive collection of gene expression information for thousands of genes at a time.

Microarrays have been used successfully in a range of applications including sequencing and single nucleotide polymorphism (SNP) detection. However, main focus remains in the investigation of the genetic mechanisms in the living cells. Some typical examples are comparison of healthy and malignant tissue, studying cell phenomena over time as well as study the effect of various factors such as interferons,



Bioinformatics translates the data generated by microarrays



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cytomegalovirus infection and oncogene transfection on the overall pattern of expression.

In summary, microarrays give a global view of the genome and help in the identification of targets and pathways which network together to manifest a

certain phenotype. In its present forms and variants, it has proved to be a powerful tool in genomic research.

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FISH OUT PROFIT IN AQUACULTURE IN EVERY VILLAGE

Dr. H. Muralikrishna

New technologies of aquaculture developed by the Central Institute of Freshwater Aquaculture (CIFA) in Bhubaneswar, Orissa have shown promising results. Fish Production of more than a quintal in a year is possible from a tank of 1000 litres capacity. The technologies developed were tested in the small and marginal farmers' fields and proved to be profitable.



According to the available statistics, 71 lakh metric tones of inland fishes is produced in our country every year. These fishes are from three main groups called carps, catfishes and prawns. Besides, ornamental fisheries and molluscan culture too are proved to be profitable. The countries target for the year 2020 is 110 lakh metric tones of fish production from inland freshwaters.



Fast growing breeds of fish including the Rohu 'Jayanti' released by CIFA, Bhubaneswar by adopting integrated scientific aquaculture practices along with crop plants, livestock such as pig, duck and poultry can fetch a net income of Rs. 1.5 lakhs in a year.

Rural aquaculture can be sustainable through community approach, wherein, essential inputs are locally available. Production of seed, fry and fingerlings in right season and in required quantity is important. Fibre glass reinforced plastic (FRP) are highly beneficial for portable tanks which facilitate fish hatchery. Production of 10 lakh spawn by using CIFA technology can give a net return of ₹ 44,000/- annually. Each fish cultivating community has the demand for a portable

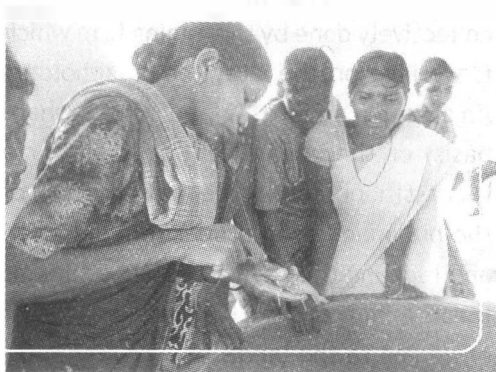
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FRP hatchery for supply of seeds to the sustainability of the local farmers. A wise step to scientifically use the available water bodies would sustain the local fish demand. The vegetarians who feel fishy about this can also try integrated aquaculture and reap the untapped potential of their resources.

According to Dr. J.K. Jena, Principal Scientist of CIFA, in our country only less than a half of the water bodies are used for aquaculture. The challenges posed by the conversion of water bodies in to real estates by filling up with earth, increasing drought situation in other majority of the areas making a lot more dearth for freshwater as well as policies and concerns against conversion of paddy fields exist. Still, the technologies developed by CIFA promise more than 6% growth in aquaculture production in the coming two decades.



For rural enterprising unemployed youth, the Japanese model of pearl culture by growing shell fishes is another area where the aquaculture scopes are increasing. The vanilla plant, which was once felt as a tough and secretive crop, is now being easily pollinated by household women and the same can be taken as an encouraging example. In similar manner, skills of shell fish surgery to implant particles inside the body in between the flesh and shell can be easily acquired by the skillful youth. CIFA has come out with new technologies wherein desired shapes and design pearls can be produced. The new mantle implantation technology promises approximately ₹ 2 lakhs net returns from one acre of water body.



By the project being implemented all over the country and tanks, being dug by the beneficiaries of the scheme, they can be utilized for harvesting profit from them. With proper planning and ecological concerns properly being understood, aquaculture can be adopted in every villages for a big haul of benefit.

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ISSUES AND CONCERNS WITH MINE CLOSURE

Shivam Shahi and Harsha Vardhan

What is mining?

Mining, in its broadest sense is the process of obtaining useful minerals from the earth's crust. Mining normally means an operation that involves the physical removal of rock and minerals from inside the earth as well as from the earth's surface. There are mainly two types of mines such as underground mines and opencast mine. Underground mining process includes excavations from the interiors of the earth while opencast mining mainly deals with extracting ore and minerals present at the surface. Mining is one of the core sector industries which play a positive and significant role in the process of country's economic development with some unavoidable environmental impacts. According to Prof. B.B. Dhar, "The real conflict is not between environment and development, but between environment and reckless exploitation of man and earth in the name of efficiency".

Most of the minerals which are used in our everyday life are products of some mining operation e.g. base and precious metals, iron, uranium, coal, diamonds, limestone, oil, shale, rock salts, potash

etc. Besides, recent technological developments will soon make even seafloor mining economically feasible. The nature of mining processes creates a significant negative impact on the environment both during the mining operations and also for years after its closure.

Mine closure

Mine closure is a complex phenomenon of closing a mine due to technical, social and economic conditions prevailing. It is a conceptual process involving planning, cost estimation and rehabilitation of the employees working in the mine before its closure. The plan is not made overnight but it is a result of continuously reviewing throughout the life of the mine for the changes occurred during the actual mining operation. The planning should be collectively done by the mining firm which is working on the site, the stakeholders (in case of a private mine running on share basis) or the government officials for a successful outcome. The main concern of the planning lies in proper rehabilitation and tackling the environmental problems that is minimizing the loss done on account of mining to the land.



The process undertaken by the mining firms before submitting the land to the government or the stakeholders are reconstruction or filling of the surface mined to maintain the ecological balance, disposal of toxic materials, restoring the pre-mining condition, soil development and reconstruction of habitats. Further, social aspects should be undertaken by the firm such as successful environmental closure which can be used for farming and providing jobs to local workers post mine closure. The social responsibility is commonly shared by the government as well as the mining company. Even though closure issues are different from mine to mine depending upon their conditions, it is possible to develop a set of principles to assist the company, government and the individual working to ensure maximum benefit to all of them. In some countries guidelines are framed by the respective

government regarding mine closure, which are to be kept in mind before planning the whole process.

Reasons of mine closure

There may be several reasons of closing a mine. However, some of the important ones are as follows:

- Exhaustion of the reserves present in the mine and no possibility of further discovery of ore body near the area.
- Technical conditions not suitable for further working due to high strata pressure or high water table including any other technical conditions which cannot be solved. For example, a diamond mine of De Beer's in South Africa was closed recently due to power shortage.
- If the mine is no longer economically viable or in other words runs in losses.



Mine in operation



- If it is not possible to carry out mining operation due to unstable social conditions prevailing like, closure of mines in Papua New Guinea and in African Nations due to frequent violence.

Government of various countries enacted laws for the closure of the mine which governs the closure of mine systematically. Government of India also have a National Mineral Policy 1993 which emphasizes the issue of rehabilitation on mine closure. The responsibility of technical and safety aspect lies within the mining firm and government. There are several concerns while closing a mine like:

- The overall economic and social impact of closure
- Employment impact of mine closure and its remedies
- Development of alternate economic base for the employees of the mine
- The environmental consequences including disposal of harmful and waste material and refilling of the excavated area
- Participation of local government in providing alternate employment to the employees

Steps involved in mine closure

When deciding to close a mine, the idea should be to restore land, water, biological and ecological resources etc. to the pre-mining condition of that particular area. This is the reason, why mine closure is site specific.

Landscaping

Closure of mine requires filling of the mined land with waste material (includes soil/rock which were removed to reach the ore body) in order to match the topographical condition of the surrounding. Estimates indicate that for extracting about 20 billion tonnes of mineral raw materials, the mining industry has to excavate and move about 200 billion tons of earth and rock mass. Globally out of this 90% which needs is waste, needs to be disposed off in an ecologically sustainable manner. If the ore contains sulphides, it is usually covered with a layer of clay to prevent contact to rain and oxygen from the air, which can oxidize the sulphides to produce Sulphuric acid. Further, it is essential to return the land in safe, stable and fertile condition which can be readily accepted by local community. The land should be returned in such a way that:

- There is no additional maintenance and assistance required for future use of the land
- There is minimal need of monitoring of the land after the closure

If it is not possible to fill the entire excavated area, then the pit (excavated area) is fenced to prevent access of animals. Such excavated area generally gets filled up with rain and ground water. Many mines in India and abroad have developed such areas as tourist places by creating amusement parks for adults and children and developing boating facilities in the inundated area.



Restoration of biological and ecological system

Any mine closure should aim at restoring both the biological and ecological resources which were existing before the start of the mining operations. Therefore, the biological and ecological resources are considered as part of normal rehabilitation programme in mine closure planning. The biological reconstruction should be aimed at habitat, soil and ecosystem restoration rather than only vegetation of the area. Every attempt should be made to protect and conserve biological resources of that area to the extent possible. Some of the steps undertaken for the biological and ecological rehabilitation include:

- Re-vegetation of plant species that will support the approved land use

- * Planting should be done during the most favourable period to ensure proper land cover
- * Soil stabilization and irrigation must be practised to establish the vegetation
- * Different species of herbs and shrubs are established at the site to check the erosion.

Health, welfare and social development

It is not evident that health problem will occur to the workers and neighbouring communities during the actual operation of the mine. Many diseases develop over a period of time due to environmental pollution caused from mining activities like different types of respiratory diseases. A health risk chart by every mining firm needs to be prepared before mine closure to know more about the



Re-vegetated area after mine closure

diseases that might occur post-mine closure due to environmental impacts of mining like air and water particularly due to ground water. In USA a special policy deals with this, called as National Environmental Policy Act which considers the effects of the environmental pollution after the mine closure. Adequate checks and health facilities should be established by the mining firms to cater the needs of the local community in this regard.

Social effects of mine closure are quite adverse if it is not dealt in a proper way. In most of the developing countries and underdeveloped countries, mine closures have exceeded that of the opening of new mines. With thousands of workforce displaced from their jobs, there is a huge responsibility on the mining firm as well as the local government to rehabilitate them so that they can again join the mainstream of economy without much problem. Advance planning and close cooperation by the company with local authorities, communities and non-government organisation is a key to successful mine closure and achievement of post-mine closure stability. Successful environmental closure can greatly help the social sustainability of the community in the post closure period - especially for the farming communities. Workers working in the mine should be properly counselled and trained about vocational training and alternate job options. They may be either adjusted in other industries or mine if possible or given some money to start new small scale enterprises. They may be given land for farming and other animal rearing activities that can be easily

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started. A new concept has been established by mines in Papua New Guinea as "Future Generation Funds" to provide some money to the worker after the closure of mine.

Conclusion

Planning for mine closure is progressively becoming recognised as an important component of the management of the mining sector. To date, emphasis has been placed on formulating approaches to address the negative impacts of the closure of large-scale mines. Though the environmental aspects of mine closure have played a routine part in mine planning in many countries including India, the socio-economic challenges have only recently started to receive systematic attention in our country. It is hoped that with joint effort from the government, mining firms and other stakeholders, the various problems associated with mine closure will be minimal.

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SCIENCE AND ADVAITA

T.M. Jayaraman

Advaita the non-dualist philosophy of India, with its *indivisibility postulate* for Reality, is considered to be the pinnacle of human speculative endeavor. It is a philosophy that integrates philosophies, which is its uniqueness. It brings all possible dualist theories (with Subject - Object division) under its common epistemological umbrella by an evolutionary approach. The dualist theories are distinct stages in the evolution of knowledge, to be understood by applying the discriminative faculty. Lack of discrimination of the distinct evolutionary stages results in confusion of thought leading to sectarianism and quarrels. Discrimination - NOT division - is the key word in Advaita. Advaita's relevance has a timeless quality, and it can play a meaningful role even in organizing the theories of Modern Science.

Sankara (about 800 AD), the philosopher-saint is reputed to be its chief proponent. Bharthruhari (about 650 AD), the grammarian - linguist, was an earlier *Advaitin* who made major and significant contributions. Sankara's concern was with the spiritual uplift of the individual human being. But he saw it as a purification of the intellect by developing discriminative knowledge (*Viveka*). Pure knowledge (*Jnana*), which is the same as the knowledge of the supreme spirit, was the highest goal for him (Radhakrishnan, 1940). The secular Bharthruhari was preoccupied with the primary generation and communication of ideas and information.

His work has direct relevance in the modern world (Potter 1981, Kunjunn Raja 1990).

Thus, irrespective of the subjective or objective predilections of its exponents, Advaita always zeroed-in on a universal evolutionary theory of knowledge applicable to all possible philosophical stand-points conceivable by man. It is just that what appears as "evolution" objectively will invariably appear as "creation" to the egoism of the subjectivist with a diametrically opposite perspective. The Reality is the same in either case, and there is no ground for quarrels. It will be seen that non-dualism unites the subjective and the objective by proper discrimination - NOT division. The different objective points of view (or theories) belong to different evolutionary stages, and are to be systematised by proper discrimination. Evolution in Advaita is more thorough-going and deeper than in modern science, where it applies only to the biological sciences (Jayaraman, 2004).

Briefly stated, Advaita posits an ultimate reality, indivisible (even into a Subject and Object) and without qualities. The whole world is viewed as "*Vivarta*" or evolutionary phenomenon based on it as the template. The template remains unaffected throughout.

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Briefly stated, Advaita posits an ultimate reality, indivisible (even into a Subject and Object) and without qualities. The whole world is viewed as "*Vivarta*" or evolutionary phenomenon based on it as the template. The template remains unaffected throughout. *Vivarta* may be viewed as monoacting by Reality in the roles of "The Subject" as well as the "Object", separately and repeatedly. This is the primary "*Vivarta*".

A classic example from the ancient sanskrit theatre will illustrate the process. The actor monoacts on the stage as God the "Subject" (the mute watcher) as also the quarrelsome Goddess throwing tantrums (the object), alternately and repeatedly changing the roles. The never-ending repetitions of the quarrel scene constitutes the phenomenal base of the manifested world. The tantrums of the Goddess then evolve, through several orders of manifestations, into the world in all its variety. The dramatics of the example is unimportant. But it gives a clear and graphic insight into the process by which dualist information is generated from non-dual awareness. In the modern parlance of molecular genetics (but at a deeper level) it is an abstract version of the copying of information from a template that itself remains unaffected.

Even the sense of "*time*" is just an evolute in Advaita (Jayaraman 2006) with the never-ending repetitions of the monoact serving as the fundamental or cosmic clock process (this should be of interest to the fundamental physicists and information theorists). The cosmic evolution, from the cosmic

complacent state (*Ananda*) of just the time consciousness and nothing else, proceeds through past memories, before - after and cause-effect algorithms (*the cosmic mind and intelligence*) to space as the cosmic background for matter, motion and the dynamics of motion culminating in the appearance of bio-matter and metabolism (*the cosmic prana*), finally ending with the appearance of the human frame-works (*the sariras*) as the multiple intelligence and control centers. Please note that this knowledge, when taken backwards, transcends bio-matter, energy, matter, space and time in that order (elimination of space leads to *deharakasa* or zero-dimensional space). Standard Advaita vedanta usually follows this reverse development from the human condition to cosmic bliss in its spiritual quest.

Modern science agrees with Advaita in the practice of a thorough going "Subject - Object" discrimination in its clinical detachment during investigation and reporting. The 19th century French Positivist, August Comte, had attempted a classification of the modern sciences in a hierarchy: *Mathematics, Astronomy, Physics, Chemistry, Biology* and *Sociology*. A simpler modern version (Jeans 1942) have *Mathematics, Physics, Biology* and *Sociology*. Psychology must be placed between Biology and Sociology. The principle underlying the classification did not indicate an evolutionary approach.

An attempt to match the evolutionary stages and substages of Advaita with the Positivist classification could prove fruitful for both. In spite of its philosophical merits, traditional



Advaita developed in an atmosphere that lacked information in-puts. It was forced to appeal to an illusion theory in respect of practical details. Modern science, with its surfeit of organized quantitative details, is eminently suited to fill this lacuna. Advaita is NOT an illusion theory or individualist theory, as often portrayed even by its proponents. It is a representation theory where ultimate reality remains unaffected by the generation of the representation. It has also transpersonal levels.

There are several problem areas in present day fundamental Physics where lack of discrimination could be diagnosed. An obvious example is the mix-up of classical mechanical and quantum mechanical concepts. It could very well be that classical dynamical concepts of mass, energy and momentum are inapplicable at the more fundamental quantum level. The Planck's constant " h " can be cited as the eliminating constant. This saves the quantitative formulae, but throws the verbally expressed theories out of gear. It is exactly what is happening in present day quantum theory. A quantum verbal theory without the classical dynamical concepts of mass and inertia will have to be constructed from scratch to free it from confusion, and make it understandable.

Consider the uncertainty principle of Physics. In fact the accuracy of fundamental measurements have increased by leaps and bounds (from about one in a thousand to about one in a billion) consistently throughout the last 500 years or so of its existence. Yet, a feeling of uncertainty crops up, as the verbal descriptions

fail to match the higher level of awareness attained quantitatively.

Consider the problem of unification of forces in Physics. This problem gets automatically solved if one moves to a theoretical level where force and inertia concepts are absent. The real problem is to work out such a theory and establish its correspondence relation(s) with classical Newtonian mechanics (Jayaraman, blog). The famous problem of divergencies in quantum field theories too vanish when energy and mass are NOT the relevant fundamental quantities or concepts.

Thus synergy of modern science pursued under Advaita's epistemological umbrella could very well take it to the Final Theory, and beyond.

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Microfossils - An invaluable tool for paleo-analysis

Shirshendu Deb

Fossil - what is it actually?

Fossils, as we all know, are the remains of past life. A microfossil is fossil whose distinguishing characteristics are best studied by means of the microscope. Micropaleontology is the systematic study of microfossils, their classification, morphology, and environmental and stratigraphic significance. Microfossils include: 1) remains of complete skeletons of entire organisms, 2) embryonic or neopionic forms of megafossils, and 3) dissociated fragments, skeletal elements, or other anatomical units of larger fossils which are ordinarily considered to be of microscopic size. The average range of microfossils is: 0.01mm to 50 mm.

Megafossils, as the name indicates, are of macroscopic dimension. They are not found in all sediments. Microfossils are of simple type than the megafossils. Within small sediment, there may be hundreds of microfossils preserved. The most common microfossils are algae, fungi, spores, and pollen grains.

Can we really have divisions for microfossils?

Yes, it is possible. Microfossils are commonly divided into:

- Non-mineralized (organic-walled) forms, and

- Mineral-walled forms

Non-mineralized forms: Some microfossils with non-mineralized tests are remarkably resistant to microbial as well as chemical attack and to a certain extent to the effects of temperature and pressure after burial. These are called palynomorphs. They represent the most resistant group of microfossils, and include some dinoflagellate cysts, spores and pollen.

Mineral-walled microfossils: Diatoms and radiolarians have silica tests, whereas coccoliths and most fossil foraminifera have tests made up of Calcium carbonate. Consequently, the preservation of these mineral-walled microfossils depends on the acidity and other geochemical properties of the depositional and subsequent diagenetic environment. The same group of microorganisms may inhabit a wide range of environments from the abyss to the upper intertidal zone, even between small sand grains on the beach. Diatoms and foraminifera are examples of groups comprising both planktic and benthic forms. The main bulk of microfossils are remains of marine organisms. Some groups of diatoms are freshwater species, whereas pollen and spores represent the



parent plants and their environment on land even when they are found in marine sediments.

Is there any importance for studying the microfossils?

Definitely yes, most sediment contains microfossils, the kind depending largely on the original age, environment of deposition and burial history of the sediment. At their most abundant, as for example in back-reef sands, 10 cm³ of sediment can yield over 10,000 individual specimens and over 300 species. By implication, the number of ecological niches and biological generations represented can extend into the hundreds and the sample may represent thousands, if not hundreds of thousands of years of accumulation of specimens. By contrast, macrofossils from such a small sample are unlikely to exceed a few tens of specimens or generations. Because microfossils are so small and abundant (mostly less than 1 mm) they can be recovered from small samples. Hence when a geologist wishes to know the age of a rock or the salinity and depth of water under which it was laid down, it is to microfossils that they will turn for a quick and reliable answer.

Geological surveys, deep sea drilling programmes, oil and mining companies working with the small samples available from borehole cores and drill cuttings have all therefore employed micropalaeontologists to learn more about the rocks they are handling. This commercial side to micropaleontology has undoubtedly been a major stimulus to its growth. The importance of understanding

microfossils is further augmented by discoveries in Precambrian rocks; microfossils now provide the main evidence for organic evolution through more than three-quarters of the history of life on Earth. It is also to microfossils that science will turn in the search for life on other planets such as Mars.

Relationship between microfossils and Bio-stratigraphy

In general, Bio-stratigraphy refers to that portion of the Earth that portray a close relationship between sediments and organisms.

- They possess a shell or a test, which is so robust that they are not easily destroyed after their deposition.
- Many groups have a short stratigraphic range.
- They are numerous in small (a few grams) sediment or rock samples.
- They have a widespread occurrence.
- Most groups have high species diversity and are sensitive environmental indicators.

An outline for field sampling and collecting the specimens

Sediments containing abundant megafossils are most likely to contain some microfossils. Some of the strata yielding microfossils are characterized as follows:

Thin partings of claystone in fossiliferous limestones: These may vary from a fraction of an inch in thickness to several



inches. Most microfossils have calcareous hard parts, hence will be most abundant in calcareous sediments.

Limestones and dolomites: Many carbonate rocks are extremely fossiliferous, and in some instances may be made up primarily of Foraminifera or other microfossils.

Black shales: The fissile type associated with cyclothems commonly contain excellently preserved microfossils.

Field equipment for collecting microfossils includes such standard items as a field notebook, pencils, pick, compass, steel tape, a heavy sample sack or bag which is resistant to moisture, and a hand lens. An acid bottle containing a 10% solution of HCl (Hydrochloric acid) is useful for identifying calcareous shales and for etching limestone surfaces for hand inspection.

Certain precautions should be exercised during sample collection to avoid contamination, particularly if the samples are to be examined for smaller microfossils such as spores, pollen, and coccoliths. Picks and shovels should be cleaned before each sample is taken, and the particular area of rock chosen for sampling should ofcourse be thoroughly scraped or picked clean of surface wash and weathered surfaces. A fine paint brush is a useful accessory tool for cleaning rock surfaces, it will also be found useful in brushing off chunks or fragments of the sample taken, as a final precautionary measure in avoiding contamination by recent microorganisms

such as pollen and charophytes. This procedure is strongly recommended as a final step before packaging the collected samples.

A brief description of some of the well-known microfossils is as follows:

Conodonts are minute tooth-like structures composed of Calcium phosphate, and are usually a translucent amber-brown in color. Pander discovered conodonts in 1856 in the Ordovician of Baltic Russia. Microscopic examination at magnifications exceeding 150 diameters shows that their internal structure is either fibrous or lamellar (Fig A). The conodonts are excellent guide fossils in Paleozoic sediments, and range from Lower Ordovician to Middle Triassic. Whatever the animals were which bore conodonts, they were apparently adapted to a wide variety of depositional environments. Although most of them occur in shales, they are also found in sandstones, black shales, limestones, dolomites, and cherts.

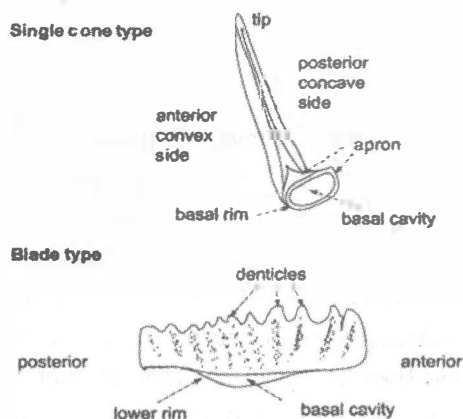


Fig. A: Conodont

Ostracods are in general quite small, ranging from 0.5 mm to 1 cm in length, although most species are from 0.5 mm to 3 to 4 mm in length. They inhabit marine and non-marine waters. The Ostracoda are typical crustaceans in that the exoskeleton is chitinous, heavily impregnated with Calcium carbonate (Fig B). Ostracods are distributed from Ordovician to present day. The body of an Ostracod is segmented with appendages. They are completely enclosed in a bivalved calcareous shell, which is the hard part of the body. It is known as carapace. Ostracods are divided into some small groups depending on the following characters:

- (a) Shape and size of the valve
- (b) Nature of the appendages
- (c) Hinge characteristics
- (d) Nature of surface features

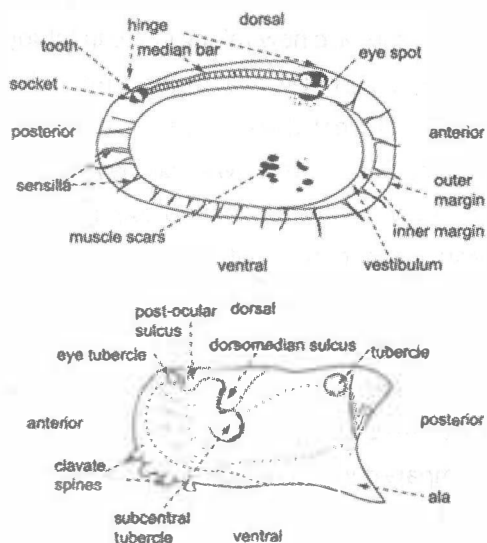


Diagram of two different idealised ostracods to show common ostracod valve features. Top internal view of a left valve, bottom external view of left valve.

After Home et al. 1989.

Fig. B: Ostracod

Foraminifers are unicellular animals differing from all other Protozoa in the possession of a network of branched or anastomosing threadlike pseudopodia and having a secreted or secreted agglutinated test of variable composition and complexity (Fig C 1,2,3). They are adapted to all aquatic habits, and most of them live in marine waters, but some can exist in salt lakes or brackish waters, and the members of one primitive family (Allogromiidae) live in freshwater. More than 35% of the present ocean is covered with ooze largely composed of their tests. Globigerina ooze is especially common. Such ooze is generally absent in the deepest part of the oceans, because the empty calcareous tests are dissolved before they reach the bottom.

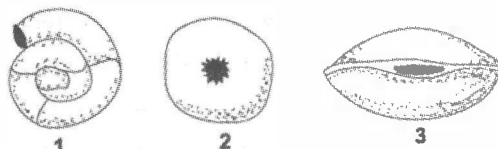


Fig. C: Apertures of foraminifers:
1- Open end tube. 2- Terminal radiate; 3- Terminal slit.

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Fostering Scientific Innovations in India: An Outlook

B. Ramkumar and Dr. R. Pratap Chandran

The beginning of the 20th century has witnessed great developments and achievements in the field of science. Many new streams of science had paved its way to the forum and prove themselves to occupy much space among the existing panel of members. Biotechnology is one among the successful members that constitute the winners of such group. The scientific innovations had made enormous leaps with the extended hands of biotechnological researches. Biotechnology was highly fortunate to extend its fast and rapid progression during a very small span of time. It occupies a highly well defined chair in the science community and it proves to be distinguished. Biotechnology gets its companion 'Information technology' along its long run and they are often referred as the partner companions "The IT and BT", is about to rule the world in the forthcoming developments that may conquer both science and technological fields of innovation. But as the fortune stars doesn't make it's blessings over the IT, it was forced to quit the scene without making much expected impact due to

several known and unknown reasons. But there are hopes that the friend of BT will make a strategic return grabbing all the strength that it needs to strive in the current scenario.

Even though the companion looses out, BT seems to strive its existence with an increased immune power which may be because of the unexploited talents that they may produce, once it is thoroughly subjugated. The biotechnological researches are now taking place in billions of research laboratories and other scientific establishments around the globe. Fortunately, we too have in our country, many biotechnology research entities that are capable of making its own fingerprints to mark the existence among the billions. But it was very surprising that the scientific community in India has not yet developed a competence to be compared with the foreign achievements and talents. While excavating the root cause for that, it could be well documented that the researchers in India are quite far better than foreign countries but still they are not able to make out a



mark in the pages of scientific developments.

Another main, important and obviously much discussed fact that can imply the pushback of our scientific developments is the lack of the young talented innovations. It seems to be a routine habit among the Indian youth that represents the major share of the scientific community to expand their future carrier prospects in foreign nations, making our country deprived of the achievements that these young brains contribute. It seems to be the strong responsibility of the officials in the governing bodies of the nation to make better policy frameworks that could help the young science students and research scholars to get facilitated with the requirements to make them hang on to the Indian science laboratories. Hence it could probably bring out the obvious result that the achievements made by these innovators may create an ample progress and development in the science community of the country bringing out the much awaited augmentation of the Indian economy into a global standards.

The contributions made by Indian scientists in the foreign research laboratories can be well commented without any fear of facts. The Indian scientists had even been awarded the Nobel Prize, but still in most cases as non-resident Indian national, hence proving the misfortune of our nation to be

recognized and ascribed by the world.

Indians constitute the inevitable part of almost all the successful foreign research teams that brings out wonderful contributions to the scientific fraternity of the world. For example there were three 'Indian origin' scientists in the team of 24 members who have created an artificial living cell for the first time in J. Craig Venter Institute in Rockville, Maryland, US which represents one of the most recent achievements in Biotechnology.

Now, it is high time for us to think strongly that this system needs a much hardened deliberate renovation. There should be much provisions and opportunities created in the Indian research laboratories that could attract the young science students and the research scholars to make them tempted to pursue their future research carrier in our country itself. But it's a fact that our Science labs are not much outfitted with the facilities that could be used as the keystones to compete with the well flourished foreign labs. So there is nothing to be astonished and bewailed over the translocation of the Indian scientific community, who are tempted by the far better infrastructure that our neighbor had primed for their carrier development.

But seeing the reality behind this trend we may feel much sorry. In most cases the young core brilliant 'Indian



youth' are exploited and are even left without proper recognition by the world. The achievements made by Venkataraman Ramakrishnan (Nobel laureate for Chemistry, 2009) is one among the few fortunate, but there are hundreds and even thousands of scientists and researchers working in foreign research labs, making remarkable achievements but remains unnoticed by the world. All these happen due to the fact that the Indian laboratories always stood last when compared with the well flourished foreign labs. Commenting on this particular issue, the major problems ultimately point the fingers to nothing but the fact that implies the lack of infrastructure facilities that could be owed by our laboratories.

Why don't we have much infrastructure facilities like the foreign laboratories? Why can't we develop the infrastructure that others could make possible? Although it feels that these questions requires a much wider platform for discussion, debates and decision making; the solution that can be simply made without all these high core brain storming deals is that, we Indians as with most other cases has to depend on foreign nations for even the minute material requirements of our research labs.

We can design things but someone else should to be there to convert the design into a material object. We have Business and Knowledge outsourcing, but all that

has to be done with the help of a hardware system that an American or a European had supplied. We design cars, we have innumerable factory outlets of almost all the world class brands, but how many manufacturers do we have? It is shame that you can count it on your fingers.

The same situation also prevails in the scientific and industrial sectors. The lack of many young people being ready to invest there brain for the science field are very drastically decreasing and had now reached a state that the much demanded technical fields are ready with captivating carrier opportunities to the technologically equipped students. This paves way to a situation that the students even at the stage of their primary schooling decide to enter the track of technical education like engineering and mechanical studies that are being followed by a good percentage of the young student community in India.

But there still prevails the deadfall of the 'brain drain' that accompanies this situation which does not require much discussion as it is a worn-out topic which had been discussed for years but still wandering in search of a solution. Another important factor that owes to this situation is a huge gap created between the science and the other industrial sectors of the county, which could obviously affect the enhancement of the science community and its future



development. Why the systems continues like this and why there is no change in this situation? If we continue to ask the questions like this, we end up with half a dozen questions that can be raised. All of them make an addition to the questions that still remain unanswered or more precisely, found to have less significance among the billions of questions that are to be addressed with immediate effect.

It is a known truth that scientific research is a not a kids play, and it is something that is only being played by bigger ones as they deals with a multi-million dollar business establishments. But why are we afraid to make investments and make much expected profit out of this great business play. It is very sad to predict that the Indian community is recognizing the importance of these innovations much slower when others took over the chance of hitting goals. But this situation also has a great positive side which is being unnoticed as only one side of the coin is always being noticed at an instance. The main example of this instance is the contributions and grants that the Indian government is extensively providing to the developing and promising science fraternity of the country, which could be thought to come out with great achievements that are expected when they are being given these grants. So it is obviously clear that the government is making our science institutes well equipped to prepare their

teams as a part of the game that is only been practiced by the bigger ones and none other than the most developed nations of the world.

But it seems to be very pathetic to express the opinion that the situation is not favorable for us. Often we are not able to compete with others which is an important factor that has to be given right significance and space among the topics that are to be discussed all over the country where all the brains of the nations should be made exhausted in finding the solution. Even this situation can be grouped among the few hundreds that remain unaddressed and unnoticed even after years of discussions and debates. Still there are some points that can be listed as the cause for the drawbacks faced by our science developments, without any discussion and much debates.

One important factor is the dependency of our nation over foreign products which as with all other cases is specifically high when commenting the science researches. The current scenario that has been persisted for over years had brought out obvious and expected results. The major outbreaks for this over dependency on the foreign products are that there is a stringent increase in our financial budget for the scientific researches in our laboratories. It even had created a worst situation as to import even the tissue paper; readers please don't rumple your forehead and cave in



your eyebrows, as it is a fact that a science student may experience.

It is high time for a developing nation like India to reduce this dependency on other foreign nations for our material requirements. Encouragements should be made from each of the nook and corner of the society to bring out a hastier and enhanced industrial revolution that could foster the development of the scientific researches. It could be possible by enhancing and making our industrial systems efficient and capable to provide the material products and equipments that can be used to support the research innovations that sprout in our scientific laboratories.

This ideas and suggestions could never find its destiny of success unless there are potential changes made in the expanding industrial sector of the country, giving a well defined space to the scientific material product's development and manufacturing.

The other main factor that could be listed as the contributing agent that causes the scientific developments to decline is the lack of opportunities that has to be given to the talented persons. It is a usual scene that has been seen in all government organizations of the country that the undeserving individuals will be given the chair which often turns to be unuseful or a headache for the society. The science field is of no difference from the same, where the

untalented persons strive to get the position restricting it from the talented ones who are really deserving. The main important output of this situation is nothing but the truth that even if the infrastructure is available there could be seen no action as the talent is the real factor that ultimately counts.

The time at which this needs a rectification is no farther from now and it is the turn of the government of the nation to take necessary decisions and make amended strategies as there should be a situation where only the deserving persons could be given the right positions. This could hence create an atmosphere where the infrastructure provided will not go in-vain and thereby bring out the much expected scientific developments in the nation.

In a country like India where brain and hard work is plenty, bringing out such changes won't be a great task to perform but all that it requires is the thorough analysis of the current systems and an effective planning to achieve the goal. Let's hope for a day when Indian scientists receive the Nobel Prize not as a non-resident Indian but as the residential Indian national.

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SCIENCE OF THE MONTH

N.S. Arun Kumar

JULY 2011

July 1: In a path-breaking discovery, the chemical biology group at the Rajiv Gandhi Centre for Biotechnology (RGCB) at Thiruvananthapuram, Kerala has identified three peptides (chain of proteins) from the skin of Indian Bronzed frog, known as *Hylarana temporalis* from the evergreen forests of Western Ghats region. The three peptides identified are 'brevinin-1 TEa', 'brevinin-2 TEa', 'brevinin-2-TEb' are powerful to kill innumerable microbes especially the multi-drug resistant gram-negative bacteria. The study report was published in the *Journal of Peptide Science*. Link: <http://rgcb.res.in>

July 2: Pakistan has become the world's sixth country and the first Muslim nation to map the genome of the first Pakistani individual. The complete genome mapping was done jointly by the Panjwani Center for Molecular Medicine & Drug Research (PCMD) at Karachi University and Beijing Genomics Institute (BGI) in China. Eminent Pakistani chemist and former Chairman of the Higher Education Commission (HEC), Dr. Atta-ur-Rehman was the first Muslim and Pakistani whose complete genome was mapped. The mapping of the entire genome took just 10 months. Link: <http://www.iccs.edu/pcmd/index.php>

July 3: Scientists have discovered that the

Lesser Water Boatman, also known as *Micronecta scholtzi* makes the loudest sound relative to its body size than any other animal on earth. The insect can make noise as loud as 99.2 decibels. The noise is big as being close as 15 meters from a running freight train. The researchers at University of Strathclyde who made this discovery have presented their work at Society for Experimental Biology Annual Conference in Glasgow. Link: <http://www.strath.ac.uk>

July 4: The Gemasolar Power Plant near Seville in southern Spain has completed the construction of the world's first solar power plant capable of generating electricity all day and night. The plant is able to produce electricity all day and night due to the fact that it has 15 hours of energy storage to back it up, when cloudy and at night too. The plant consists of an incredible 2,650 panels spread across 185 hectares of rural land. This is a 19.9 MW plant that is expected to produce 110,000 MWh or 110 GWh per year. Link: <http://www.torresolenergy.com>

July 5: The Lunar and Planetary Institute (LPI) in Houston, Texas recently hosted five undergraduate students from the Indian Institute of Science and Technology (IIST) in Thiruvananthapuram, Kerala. The students were accepted as part of the

2011 Universities Space Research Association (USRA) undergraduate student research programme. The programme was made possible through a Memorandum of Understanding (MOU) between USRA and IIST. The University of Texas at Arlington also participated in the programme as a collaborative partner. Link: <http://www.lpi.usra.edu>

July 6: Conservation efforts to save the Tasmanian devil from extinction have been given a boost by the publication of their entire genetic sequence. Tasmanian devils (*Sarcophilus harrisii*) are small carnivorous marsupials, native to the Australian island state of Tasmania. The population is in dramatic decline due to a highly contagious cancer called Devil Facial Tumour Disease (DFTD). Thirty scientists from Australia, Denmark and the USA collaborated on the study, which is published in the *Proceedings of the National Academy of Sciences*. Link: <http://www.pnas.org>

July 7: China's monopoly over rare-earth metals could be challenged by the discovery of massive deposits in thick mud at great depths on the Pacific floor. Japanese geologists studied samples from 78 sites in the centre-eastern Pacific. China accounts for 97 per cent of the world's production of 17 rare-earth elements, which are essential for making a variety of products from computer screens to electric cars. The study is published in the journal *Nature* Link: <http://www.nature.com/ng/index.html>

July 8: After 30 years, NASA's space shuttle programme finally drew to a close on today night with the successful launch of the space shuttle 'Atlantis'. Indian scientists have also contributed to the success of the space programme. Between April 29 and May 6, 1985, an Indian cosmic ray experiment, 'Anuradha', a joint venture of the Indian Space Research Organization (ISRO) and Tata Institute of Fundamental Research (TIFR), was carried on the space shuttle 'Challenger'. Link: <http://www.nasa.gov>

July 9: A team from the University of Liverpool, UK, have sequenced the genome of Naked Mole Rat (*Heterocephalus glaber*) and the "first draft" of the genome available online for other researchers. The Naked Mole, native to the deserts of East Africa, can live over 30 years. The animals are resistant to many diseases, particularly cancer. So, the researchers believe that it is a first step to uncovering the mysteries of longevity and resistance to diseases. Link: <http://www.liv.ac.uk>

July 10: Special interest magazine publisher Next Gen Publishing has announced the launch of *Popular Science*, the ninth magazine from the group. The magazine will hit the stands in August, and will cost ₹ 100. Next Gen is introducing *Popular Science* in the country, licensed from Bonnier Corporation, one of the largest consumer publishing groups in the US. *Popular Science* has been a leading source of science news all over the world,



since its inception in 1872. Link: <http://www.nextgenpublishing.in>

July 11: With the help of a mural at the mosque of Madani in Srinagar, researchers claim to have found the “first firm record” of a supernova event, which occurred in the Indian subcontinent centuries ago. Researchers from the Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research and the University of Kashmir said the mural, depicted on a door arch in the mosque, shows the supernova as a dragon-head on the tail of the Sagittarius constellation. The finding is published in the journal *Astronomische Nachrichten*. Link: <http://www.aip.de/AN>

July 12: Neptune is celebrating its very first birthday today because exactly one Neptunian year – or 164.79 Earth years have passed since its discovery. Neptune was mathematically predicted before it was first telescopically observed on 24 September 1846. Astronomer Johann Gottfried Galle and his assistant Heinrich Louis d’Arrest located the planet. It was the first planet to have been discovered deliberately. Neptune’s only earthly visitor has been the Voyager 2 which flew past the planet in August 1989. Link: <http://nineplanets.org/neptune.html>

July 13: The Potato Genome Sequencing Consortium (PGSC), an international team of scientists from industry and academia in 14 countries, has published the potato genome sequence in the journal *Nature*. In late 2009, the PGSC released a preliminary sequence of the potato

genome. The work is expected to help potato breeders to reduce the 10 to 12 years currently needed to breed new varieties and possibly will help prevent starvation in the developing countries. Link: <http://www.potatogenome.net>

July 14: University of Kerala will establish an Advanced Centre for Materials Research with financial support of the ISRO. The Centre, to be named after the great space scientist Bram Prakash, will get an aid of ₹ 100 crore from the ISRO. The project report will be presented to the Space Commission this year itself. If approved by the Commission and the Union Government, this will be a world-class centre for materials research exploring advanced materials. Link: <http://www.keralauniversity.ac.in>

July 15: India’s Polar Satellite Launch Vehicle (PSLV-C17) successfully launched the Indian Space Research Organisation’s (ISRO) GSAT-12 communication satellite today from the Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. The launch of PSLV C-17 was the 18th successive successful flight of PSLV. ISRO Telemetry Tracking and Command Network (ISTRAC)’s ground station at Biak, Indonesia acquired the signals from GSAT-12 immediately after the injection of the satellite. Link: <http://www.isro.org>

July 16: NASA says its Dawn probe should now be in orbit around the asteroid Vesta. Vesta was discovered in 1807, the fourth asteroid to be identified in the great belt of rocky debris orbiting between Mars and



Jupiter. Dawn's encounter is occurring about 188 million km (117 million miles) from Earth. Scientists think it likely that it retains a lot of water, perhaps in a band of ice deep below the surface. The robotic satellite will be spending a year at the 530 km-wide body before moving on to the "dwarf planet" Ceres. Link: <http://dawn.jpl.nasa.gov>

July 17: Researchers at the University of Illinois may have discovered a new method of tracking Tsunamis, which could potentially help current early-warning systems form a better picture of a destructive wave. According to the reserchers the undulations of water as the wave moved across the ocean caused atmospheric "gravity waves" that traveled up and caused the light phenomenon known as "airglow". The study is published in the peer-reviewed journal *Geophysical Research Letters*. Link: <http://www.agu.org/journals/gl>

July 18: IUCN (International Union for Conservation of Nature) team will visit the Great Himalayan National Park in Himachal Pradesh, to assess its diversity in Sepember. UNESCO has already placed the National Park in the list of proposed World Natural Heritage sites. The Bhitarkanika Conservation Area in Orissa, the Neora Valley National Park in West Bengal and the Desert National Park in Rajasthan are also on UNESCO's list. Link: <http://www.greathimalayannationalpark.com>

July 19: Russia's long-delayed Spektr-R radio telescope was successfully launched

July 18 aboard a Zenit rocket from the Baikonur Cosmodrome in Kazakhstan. Featuring a giant 30-foot (10-meter) wide antenna, the Spektr-R observatory is part of the international astronomy project. Scientists from more than 20 nations, including the United States, are participating in the project. Spektr-R will permit interferometry measurements during the observatory's planned five years of operations. Link: <http://www.asc.rssi.ru/radioastron>

July 20: Today is the 189th birthday of Gregor Johann Mendel, hailed as the Father of Genetics. He was born on July 20, 1822 in Heinzendorf, Austria (now in the Czech Republic). Mendel formulated the Laws of Heredity largely based on his experiments on pea plants. He died at the age of 61 on January 6, 1884. It was only after his death, the importance of his works was realized. He is also credited as a master of experimental and statistical analysis. Link: <http://www.mendelmuseum.muni.cz/en>

July 21: NASA's Atlantis space shuttle returned to Earth early today, marking the end of the space shuttle era. The Atlantis was making the final flight for NASA's 30 year old fleet of reusable spacecraft before the programme is retired. This year also marked the 50th anniversary of project Apollo. The Apollo programme was the United States space-flight effort which landed the first humans on Earth's Moon. Atlantis and the other remaining orbiters *Discovery*, *Endeavour* and the test vehicle *Enterprise* will be outfitted for display in



museums. Link: <http://www.nasa.gov>

July 22: In a joint exercise, Indian Meteorological Department, National Centre for Medium Range Weather Forecasting and the Ministry of Earth Sciences led by a team of scientists from the Indian Institute of Tropical Meteorology will soon carry out the final phase of a cloud seeding research programme for a possible application in the rain shadow regions in Maharashtra, Karnataka and Andhra Pradesh. The project is part of CAIPEX (Cloud Aerosol Interaction and Precipitation Enhancement Experiment). Link: <http://www.tropmet.res.in>

July 23: Indian Broadcasting day is observed today. Though Radio Broadcasting started in India in the early 1920's, Central Government took over the transmission only in 1930 under the name, Indian Broadcasting Service. In 1936, it was changed to All India Radio (AIR). By 1957 it attained the name, Akashvani which is now brought under Prasar Bharti. However the National Public Service Broadcasting Day is 12th November. It was on this day Mahatma Gandhi first spoke on radio addressing a refugee camp from Pakistan. Link: <http://india.gov.in/knowindia/radio.php>

July 24: NASA astronomers have discovered a fourth satellite orbiting planet Pluto. The tiny, new satellite, temporarily designated P4, was uncovered in a survey using the Hubble space telescope, searching for rings around the

planet. P4 was first seen in a photo taken with Hubble's Wide Field Camera on 3 June. It was confirmed in subsequent Hubble pictures taken on July 3 and July 18. It is the smallest moon discovered orbiting Pluto. It has an estimated diameter of 13 to 34 km. By comparison, Charon is Pluto's largest moon which is 1,043 km across. Link: <http://hubblesite.org>

July 25: Astronomers have found an enormous cloud of water - containing 140 trillion times as much as is found on Earth - floating around a distant quasar. It's also the most distant and therefore oldest body of water ever found. The quasar around which the cloud floats is one of the most powerful known objects in the universe and has an energy output of 1,000 trillion suns. The discovery was made at the Caltech Submillimeter Observatory in Hawaii. Link: <http://www.cso.caltech.edu>

July 26: NASA's Widefield Infrared Survey Explorer (WISE) mission has discovered a long-hidden companion of the Earth, the first Trojan asteroid circling the sun in the Earth's orbit. Trojans are asteroids that share an orbit with a planet, locked in stable orbits by a gravitational balancing act between a planet and the Sun. Neptune, Mars and Jupiter are known to have Trojans. Two of Saturn's moons share orbits with Trojans. Link: <http://www.nasa.gov>

July 27: A Chinese mini-submarine dove 5,057 metres today in the Pacific Ocean as it seeks to claim the title of deepest-



diving submersible. It is a part of the "Jiaolong project" which began in 2002, as a part of a programme by China to explore the seabed for raw materials. The Jiaolong did not reach the 6,500 metre-depth, set by the Japanese Shinkai submersible in 1989, but its designer said it could eventually dive 7,000 metres. Link: <http://www.nasa.gov>

July 28: In recognition of outstanding contributions to the Ocean Science & Technology, the Ministry of Earth Sciences honours Dr. B.L. Deekshatulu with National Award in Ocean Science and Technology for the year 2011. Dr. B.L. Deekshatulu was instrumental in the formation of Marine Satellite Information Service (MARSIS) programme, in 1992, of Department of Ocean Development (presently Ministry of Earth Sciences) and Department of Space. Link: <http://dod.nic.in>

July 29: A streak of light believed to be an UFO was caught on camera above Fort Worth, Texas by local television station KXAS at 5:40 a.m. today. Watched on live television, the UFO zoomed down rapidly from the top of the screen, appeared to stop when it hit land, and then exited to the right at approximately a 45 degree angle. Robert Kessler, Senior Systems Engineer at CSS, pointed out that the UFO could be a meteor. The Perseid, Delta Aquarid and Alpha Capricornid meteor showers are all active at the moment. Link: <http://youtu.be/3UimdYBzKOU>

July 30: Researchers, led by an Indian origin scientist, have indicated that exposure to second hand smoke (SHS) is associated with increased risk of hearing loss among adolescents. Studies have associated exposure to second hand smoke prenatally or during childhood with various health conditions, from low birth weight and respiratory infections to behavioural problems. Children exposed to SHS are more likely to develop recurrent otitis media. The study has been published in *The Archives of Otolaryngology Head and Neck Surgery*. Link: <http://archotol.ama-assn.org>

July 31: A research team from Seoul National University (SNU) said the genetically modified female Beagle, named *Tegon* has been found to glow fluorescent green under ultraviolet light if given a doxycycline antibiotic. The dog was created using the Somatic Cell Nuclear Transfer technology that the university team used to make the world's first cloned dog, *Snuppy*, in 2005. The latest discovery published in '*Genesis*', an international journal, took four years of research to make the dog and conduct the necessary verification tests. Link: <http://onlinelibrary.wiley.com>

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SCIENCE INDIA QUIZ

Send the correct answers to Science India office or to arsmenon@gmail.com/scienceindia2010@gmail.com latest by 20th September, 2011. A science book as prize awaits you. If there are more than one correct entries, the winner will be selected by draw of lots

- Editor

SCIENCE INDIA QUIZ NO. 22

1. The oil in the wick of an oil lamp rises up due to -----
2. Gas leaked in Bhopal Gas Tragedy
3. Fungi are plants that lack -----
4. Tibia is a bone found in the -----
5. Taking into account the three isotopes of hydrogen and three isotopes of oxygen occurring in nature, how many different kinds of water molecules can we expect ?
6. Typhoid and Chlorea are typical examples of ----- diseases
7. The discovery attributed to R.A. Smith
8. The only mammal that can fly
9. The branch of mathematics concerned with the study of rate of change of one variable quantity with respect to another, and the slope of a curve at the prescribed point, and the calculation of the area bounded by curves
10. Wadia Institute of Himalayan Ecology is located here

Answers to Quiz No. 21

1. High resistance and low melting point 2. Solid Carbon dioxide 3. Transpiration
4. Insulin 5. Bleaching powder 6. Eyes 7. Achacology 8. Barograph 9. Calcium silicate 10. Deejeevugen

**The winner is Kum. Saranya Mohan, Govt. Girls High School,
Ottappalam CONGRATULATIONS !!!**